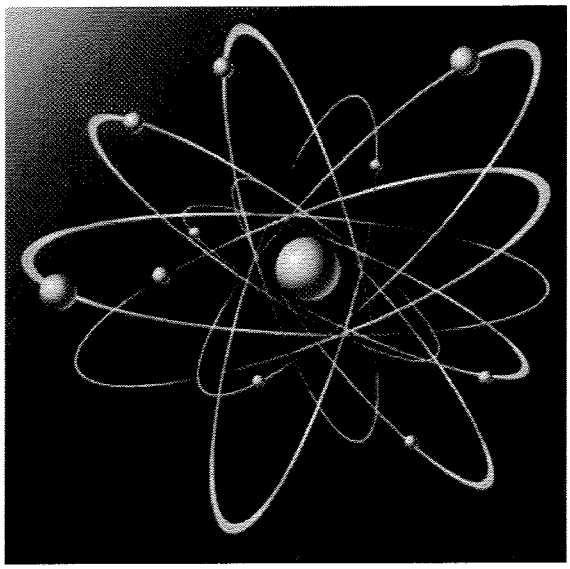
AP PHYSICS 1



SUMMER ASSIGNMENT

VECTOR ALGEBRA

RULES:

1. 0° = same direction: ADD (maximum resultant)

2. 180° = opposite direction: SUBTRACT (minimum resultant)

3. Vectors at right angles (90°): use the Pythagorean theorem & SOHCAHTOA

$$a^2 + b^2 = c^2 \qquad \cos\theta = \frac{ADJ}{HYP}$$

$$\sin\theta = \frac{OPP}{HYP} \qquad \tan\theta = \frac{OPP}{ADJ}$$

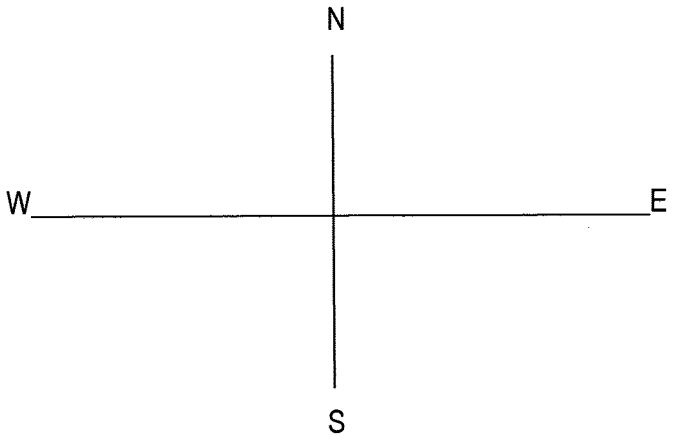
4. Vectors at "other" angles: use Laws of sines and cosines:

$$c^2 = a^2 + b^2 - (2ab \cos C)$$

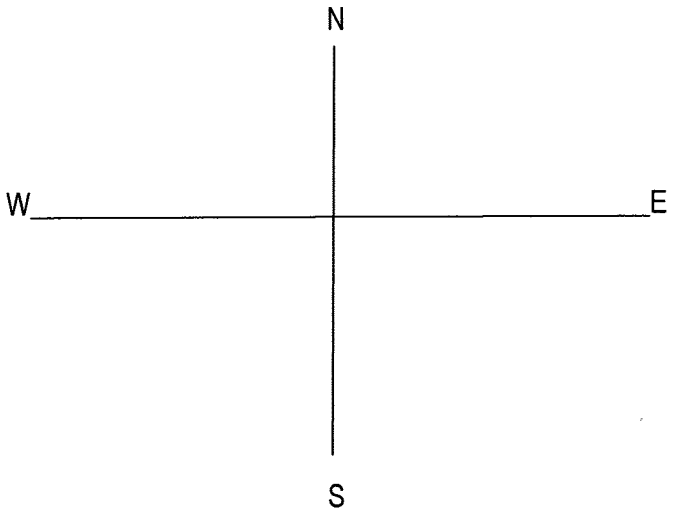
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

For each of the following problems, **show all work**, including the equation and substitution with units.

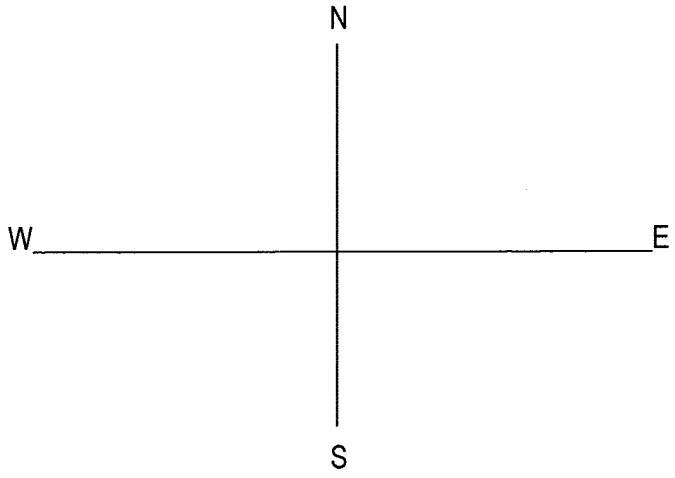
1. A small plane flies due west with a speed of 86 m/s while a tailwind blows due west at 28 m/s. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction of the plane's resultant velocity.



2. Two forces act on an object. Force **A** equals 21 Newtons directed due south and force **B** equals 17 Newtons due north. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction of the resultant force.

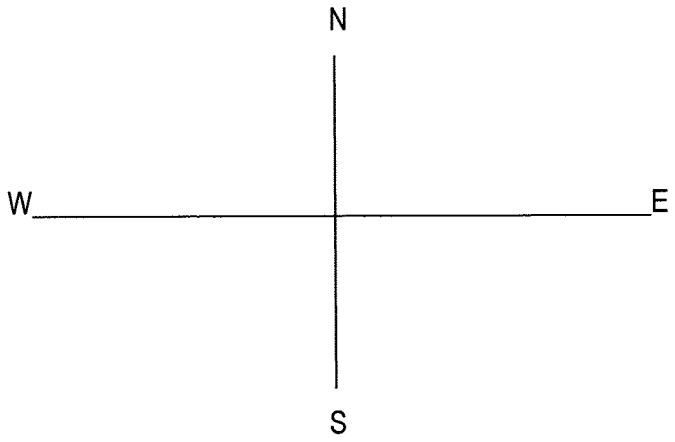


3. A woman hikes 1850 meters due east, then 650 meters due west, and finally 2120 meters due south. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction (including a specific directional angle, θ) of the woman's resultant displacement, relative to her starting point.

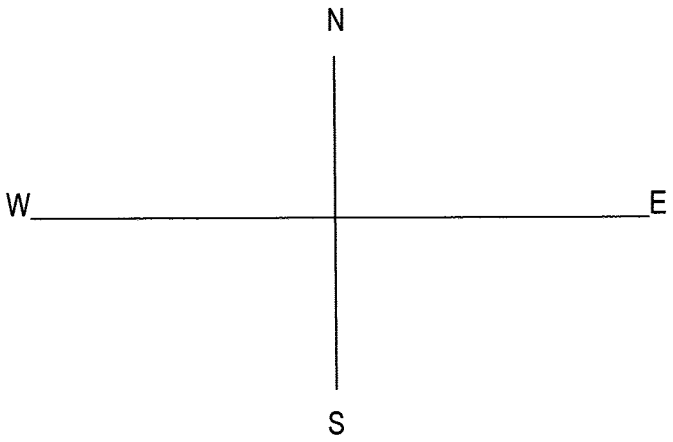


4. Force **A** has a magnitude of 45 N and is directed due east. Force **B** has a magnitude of 39 N and is directed due north.

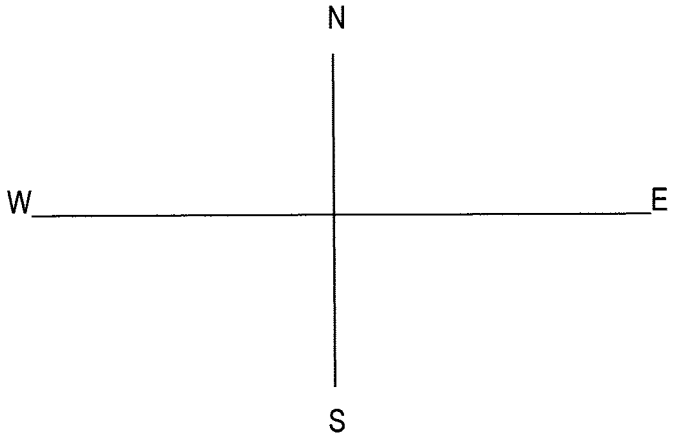
(a) Calculate the magnitude and direction (including a specific directional angle θ) of **A + B**. Include a labeled vector diagram in your solution.



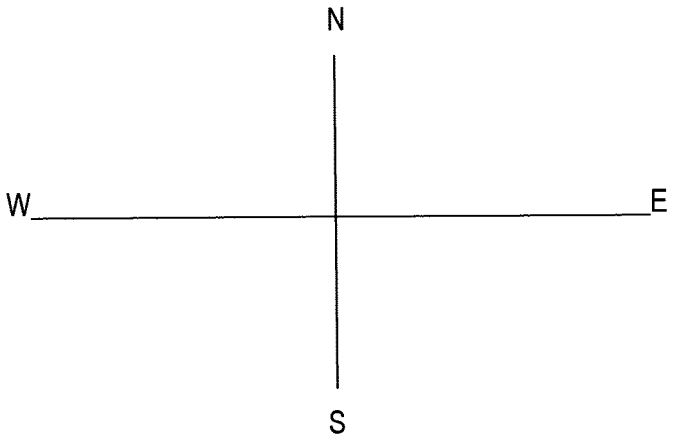
(b) Calculate the magnitude and direction (including a specific directional angle θ) of **A – B**. Include a labeled vector diagram in your solution.



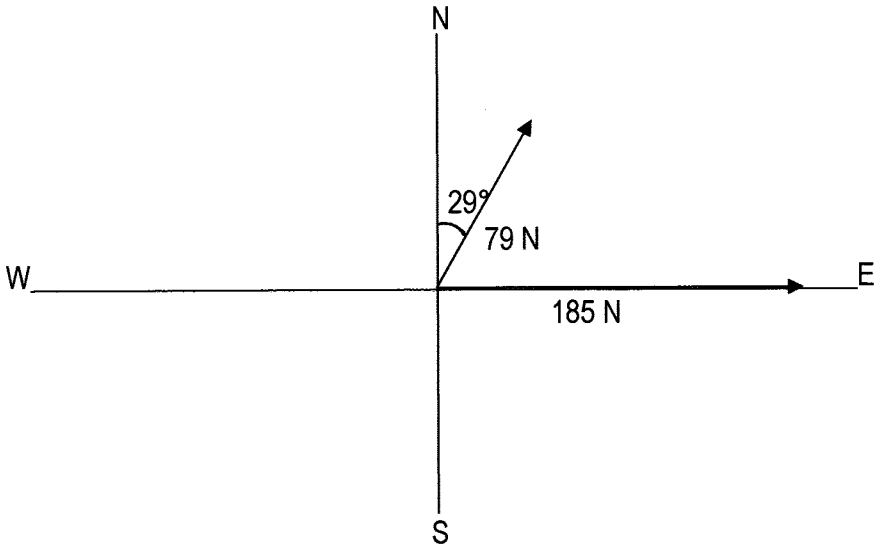
5. A bug crawls 22 cm due north, then 15 cm due west, the 7 cm due south and finally 12 cm due west. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction of the bug's resultant displacement. Include a specific directional angle θ in your answer.



6. A ship traveling at a velocity of 38 m/s at an angle of 32° south of west is acted on by a wind blowing at a velocity of 15 m/s at an angle of 26° east of north. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction of the ship's resultant velocity. Include a specific directional angle θ in your answer.



7. Two forces of 79 N and 185 N act on an object, as shown in the diagram below.

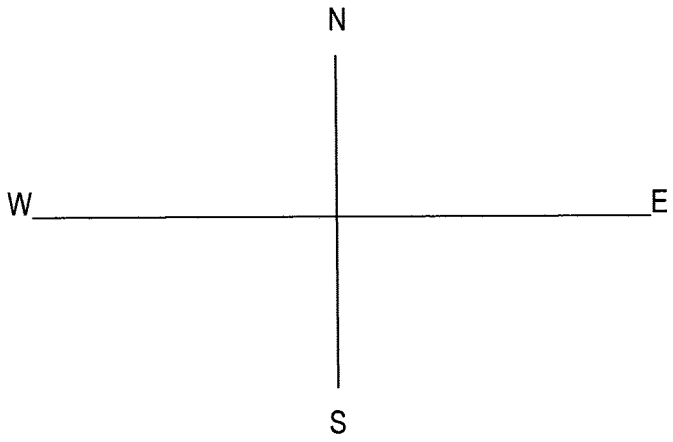


Calculate the magnitude and direction (including a specific angle θ) of the resultant force **and** the equilibrant force.

8. Two forces act on an object.

   Force **A** = 46 N due west
   Force **B** = 163 N directed 56° east of north

   Calculate the magnitude and direction (including a specific angle θ) of **A + B**. Include in your answer a labeled vector diagram.



VECTOR COMPONENTS

EQUATIONS:

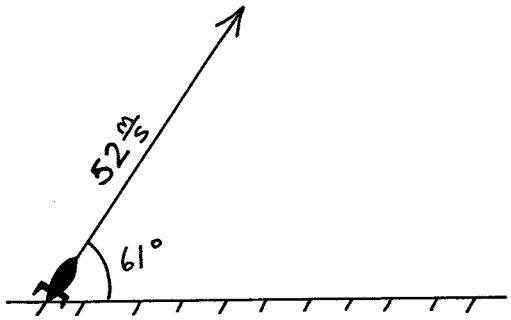
$A_x = A \cos \theta$

$A_y = A \sin \theta$

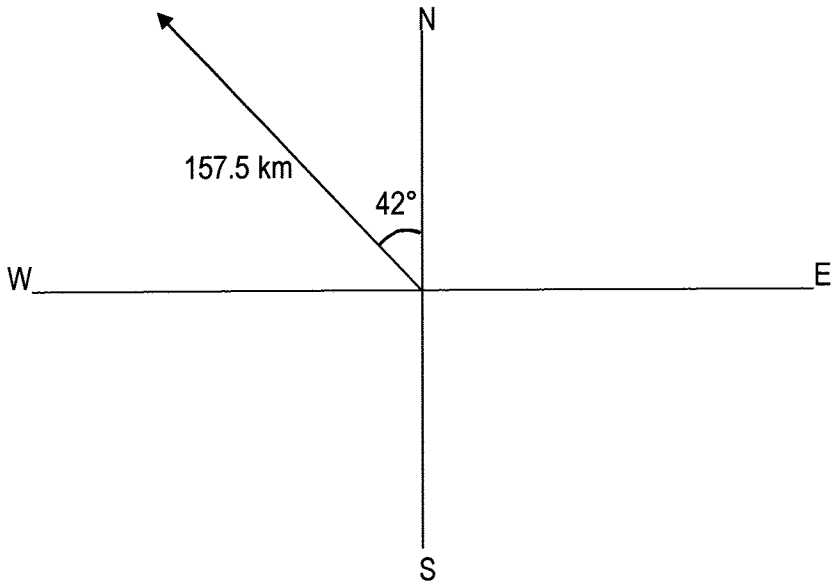
} **These equations are valid if θ is measured from the x axis!**

PROBLEMS: For each of the following problems, **show all work**, including the equation and substitution with units.

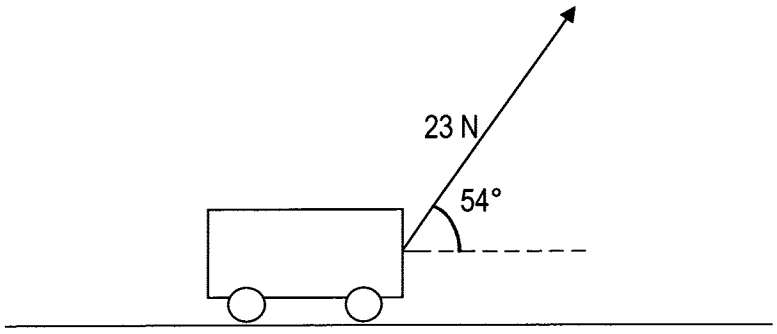
1. A toy rocket is launched upward at a velocity of 52 m/s at an angle of 61° relative to the level ground. Draw and label the components on the diagram below and calculate the magnitudes of the vertical and horizontal components of the velocity.



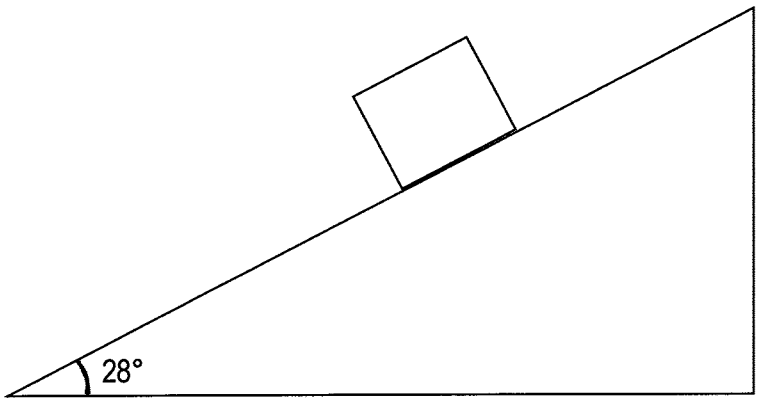
2. A plane is flown 157.5 km in a direction 42° west of north. Draw and label the components on the diagram below and calculate the magnitudes of the western and northern components of the plane's displacement.



3. A wagon is pulled by a 23 N force applied to the handle, which makes an angle of 54° with respect to the ground. Draw and label the components on the diagram below and calculate the magnitudes of the vertical and horizontal components of the applied force.



4. A block whose weight is 85 N is placed on a 28° incline, as shown below.



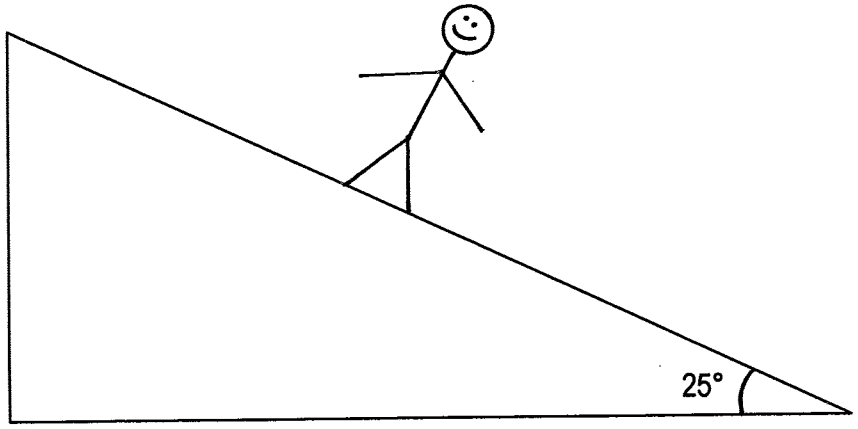
(a) Draw and label the components of the block's weight that are parallel and perpendicular to the incline and calculate the magnitude of each component.

(b) If the angle of the incline is decreased, how would the parallel and perpendicular components be affected, if at all? (increases, decreases, remains the same)

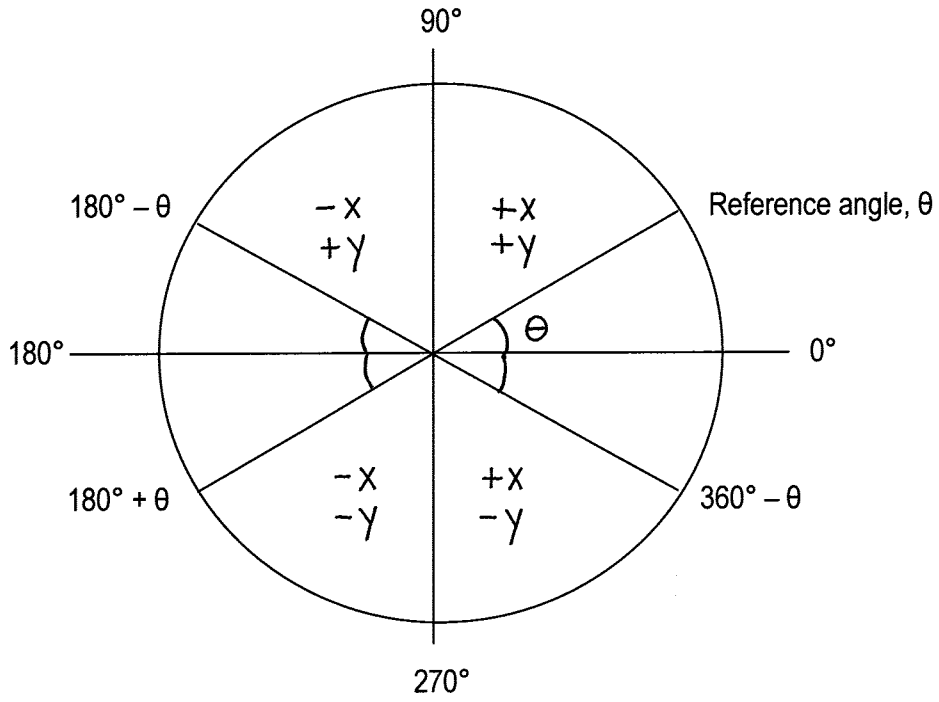
$A_{\parallel}$ _____

$A_{\perp}$ _____

5. A person weighing 752 N stands on a 25° incline, as shown below. Draw and label the components of the person's weight that are parallel and perpendicular to the incline and calculate the magnitude of each component.



TRIG REVIEW



PROBLEMS:
For each of the following pairs of components, determine the magnitude and direction (θ) of the resultant vector.

1. $A_x = -7$, $A_y = +3$

2. $A_x = +9$, $A_y = +14$

3. $A_x = -5$, $A_y = -7$

4. $A_x = +6$, $A_y = -13$

COMPONENTS METHOD PROBLEMS

1. A person drives 12.6 km in a direction 51° west of north, then 4.7 km due south and finally 8.2 km at 33° north of east. Calculate the magnitude and direction of the person's resultant displacement. Include a specific directional angle in your answer.

2. Three forces act on a body. The magnitudes and directions are as follows:

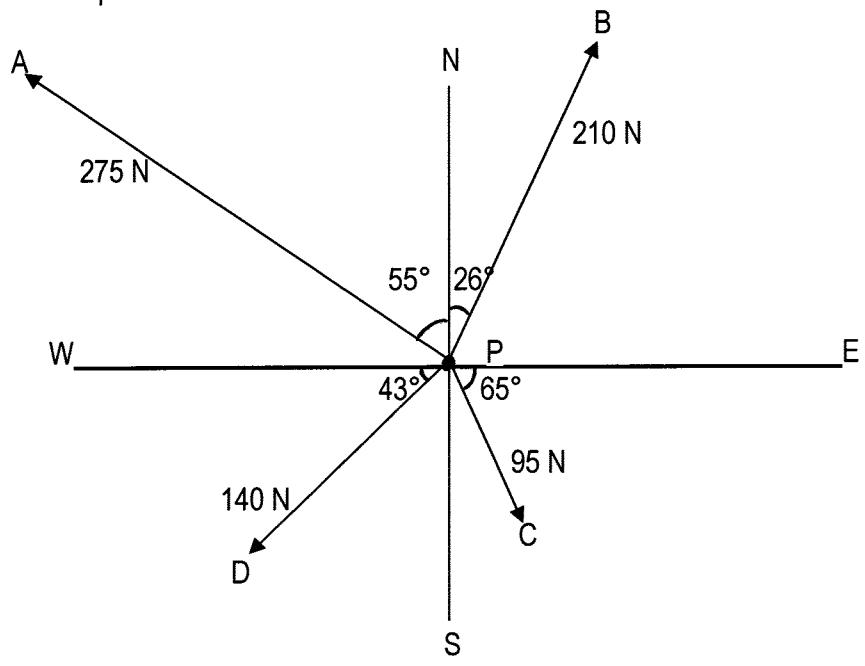
Force A = 55 N, 49° west of south
Force B = 26 N, 28° west of north
Force C = 84 N, 33° south of east

(a) Calculate the magnitude and direction of **–A + B + C**. Include a specific directional angle in your answer.

(b) Calculate the magnitude and direction of **+A – B – C**. Include a specific directional angle in your answer.

3. A man jogs 935 meters at 26° south of west, then 662 meters due west and then 730 meters at 41° south of east. The fourth part of his jog is unknown. The man ends up back at his starting point. Calculate the magnitude and direction of the fourth part of the man's jog.

4. Four forces act on point P, as shown below. Calculate the magnitude and direction of the resultant force and the equilibrant force.



5. A woman bikes 2.3 km due east, then 1.6 km at 35° east of north and continues for an unknown distance in an unknown direction. She ends up in a location that is 1.2 km at 10° west of south of where she started. Calculate the magnitude and direction of the third part of her bike trip. Include a specific directional angle in your answer.

UNIT CONVERSIONS

1 mile = 1.609 km	**1 mile = 5280 feet**
1 km = 0.6214 mile (mi)	**1 Newton (N) = 0.2248 lbs**
1 meter (m) = 3.281 ft	**1 lb = 4.448 Newton (N)**
1 inch = 2.54 cm	**1 kg = 0.0685 slug**

PROBLEMS: Using the factor-label method and the given conversion factors (and any others you may know), convert the following quantities. Be sure to **show all work**, including how the units canceled out!

1) 1,760,000 inches = _____ km

2) 885 N = _____ lbs

3) 5500 inches/sec = _____ km/hr

4) 66,000,000 m/week = _____ ft/sec

5) 2.44×10^{-2} km/hr = _____ in/sec

6) 3.0×10^{8} m/s = _____ mi/hr

7) 1.44×10^{3} lbs/ft^2 = _____ N/m^2

8) 2.55×10^{-3} slugs/m^3 = _____ g/ft^3

9) 0.1344 km/sec = _____ mm/hr

10) 6.27×10^4 in^2 = _____ km^2

11) 0.00225 km^3 = _____ ft^3

GRAPHING PROBLEMS

1. The data table below shows x and y values obtained from the equation: $\mathbf{y = 75x^2}$.

x	y	
0.35	9.19	
0.47	16.57	
0.62	28.83	
0.94	66.27	
1.30	126.75	
1.52	173.28	

a. Determine how a graph of this information could be linearized and fill in the last column in the data table above with the appropriate values that would produce a linear graph.

b. Using the information in the data table, construct a graph on the grid below following these directions:
- Develop an appropriate scale for the x and y axis values.
- Plot and circle data points.
- Connect the data points with a "best-fit" line.

2. Using the following data:

x	y
1.1	1.56
2.3	1.08
3.2	0.72
4.5	0.20
4.8	0.08

a. Construct a graph on the grid below following these directions:

- Develop an appropriate scale for the x and y axis values.
- Plot and circle data points.
- Connect the data points with a "best-fit" line.

b. Determine the slope of the "best-fit" line.

3. The data table below shows x and y values obtained from the equation: **$y = 3\pi/x$.**

x	y	
47	0.20	
56	0.17	
68	0.14	
80	0.12	
115	0.082	

a. Determine how a graph of this information could be linearized and fill in the last column in the data table above with the appropriate values that would produce a linear graph.

b. Using the information in the data table, construct a graph on the grid below following these directions:

- Develop an appropriate scale for the x and y axis values.
- Plot and circle data points.
- Connect the data points with a "best-fit" line.

ANSWER KEY

Vector Algebra

1. R = 114 m/s, west
2. R = 4 N, south
3. R = 2436.1 m, 60.5° S of E or 299.5° cc
4. a) R = 59.5 N, 40.9° N of E or 40.9° cc
   b) R = 59.5 N, 40.9° S of E or 319.1° cc
5. R = 30.9 cm, 60.9° W of N or 150.9° cc
6. R = 26.5 m/s, 14.5° S of W or 194.5° cc
7. R = 233.7 N, 17.2° N of E or 17.2° cc
   E = 233.7 N, 17.2° S of W or 197.2° cc
8. R = 127.5 N, 45.6° N of E or 45.6° cc

Vector Components

1. A_x = 25.2 m/s A_y = 45.5 m/s
2. Western component = 105.4 Km
   Northern component = 117.0 Km
3. A_x = 13.5 N, A_y = 18.6 N
4. a) $A_{\perp}$ = 75.1 N, $A_{\parallel}$ = 39.9 N
   b) $A_{\parallel}$ decreases & $A_{\perp}$ increases
5. $A_{\perp}$ = 681.5 N, $A_{\parallel}$ = 317.8 N

Trig Review

1. R = 7.62, 23.2° above –x axis or 156.8° cc
2. R = 16.6, 57.3° above +x axis or 57.3° cc
3. R = 8.6, 54.5° below –x axis or 234.5° cc
4. R = 14.3, 65.2° below +x axis or 294.8° cc

Components Method

1. R = 8.2 Km, 69.4° N of W or 110.6° cc

2a. R = 100.6 N, 7.6° N of E or 7.6° cc

b. R = 100.6 N, 7.6° S of W or 187.6° cc

3. 1302.0 m, 43.1° N of E or 43.1° cc

4. R = 255.7 N, 40.1° N of W or 139.9° cc

   E = 255.7 N, 40.1° S of E or 319.9° cc

5. 4.2 Km, 36.1° S of W or 216.1° cc

Unit Conversions

1. 44.7 Km
2. 199 lbs
3. 502.9 Km/hr
4. 358 ft/sec
5. 2.67×10^{-1} in/sec
6. 6.71×10^{8} mi/hr
7. 6.9×10^{4} N/m^2
8. 1.05 g/ft^3
9. 4.84×10^{8} mm/hr
10. 4.05×10^{-5} Km^2
11. 7.9×10^{7} ft^3